

# Effect of Food Sources on Body Fat Percentage of Students at Diponegoro University, Indonesia

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**Abstract.** The prevalence of overweight individuals in Indonesia increased among adults over the age of 18, from 15.4% in 2014 to 21.8% in 2018. A study conducted by the Faculty of Public Health at Diponegoro University in 2023 found that 22% of college students had excessive body fat, and 70% primarily sourced their food through purchases. This study analyzed the impact of food sources on body fat in college students. It employed a cross-sectional design involving 140 students from the Faculty of Public Health at Diponegoro University, selected through proportional random sampling. The independent variable was the food sources, and the dependent variable was body fat percentage. Data were analyzed using the Chi-Square test and Multiple Logistic Regression. It was found that 49.3% of college students had excess body fat. The body fat percentage was higher among students who relied on purchasing food compared to those who cooked (OR=4.6; CI: 1.804-11.572; p=0.001). Other factors influencing excess body fat included high carbohydrate adequacy (OR=7.8; CI: 1.977-30.469; p=0.003), low nutritional knowledge (OR=3.0; CI: 1.280-6.949; p=0.011), and female gender (OR=5.2; CI: 1.675-16.088; p=0.004). In conclusion, body fat percentage among college students was influenced by food sources, carbohydrate adequacy, gender, and nutritional knowledge.

## 1 Introduction

Weight gain remains a significant nutritional concern in both developed and developing countries. Indonesia, as a developing nation, has experienced a double burden of malnutrition, with an increasing prevalence of overweight and obesity over the past few decades [1,2,3]. The prevalence of overweight individuals in Indonesia increased among adults aged 18 and over, from 15.4% in 2014 to 21.8% in 2018. Central Java ranked 20th nationally, with an overweight prevalence of 13.0% among adults over 18 years old [4]. College students, representing the late adolescent to early adulthood stage, require attention because they have different nutritional needs and dietary changes from adolescence to adulthood that can impact health [5,6,7]. National data on the prevalence of overweight among college students are lacking; however, a study conducted in 2023 at the Faculty of Public Health, Diponegoro University, found that 38.2% had excess body fat, 21.1% were overweight, and 17.1% were obese [8]. A preliminary survey in 2023 of 50 college students from the Faculty of Public Health at Diponegoro University reported that 22% had excess body fat.

Students who were overweight are highly vulnerable to degenerative diseases and other health issues. Nutritional status among college students is influenced by several factors including age, education, and household wealth [1], dietary patterns [9], fast food consumption [10], food diversity [3, 11], food availability [11], nutrient intake [3, 12, 13], sex [1,3, 14], body image [14], physical activity [14], and stress [15].

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Food sources significantly influenced the imbalanced nutrient intake among students. Most lived in dormitories far from their hometowns and families, leading them to prefer purchasing food outside due to its practicality and speed compared to cooking [16]. The lack of time for meal preparation resulted in many experiencing nutrient imbalances. This tendency to choose convenient, quick foods meant students prioritized price and taste over quantity and quality [17]. Preliminary study results showed that 70% of the 50 college students surveyed obtained their food by buying it outside.

Many studies have examined factors associated with the nutritional status of college students. However, research on the relationship between food sources and body fat percentage is limited. Additionally, indicators used to determine nutritional status primarily rely on Body Mass Index (BMI). BMI is a measurement of relative weight, not body composition. This leads to many adolescents being misclassified as obese based on BMI [18]. This study was necessary because it assesses nutritional status using body fat percentage, which is considered a more accurate method for evaluating the body fat status of college students.

The researcher selected the Faculty of Public Health at Diponegoro University because it is a prominent state university in Semarang, with students from various islands and provinces, each having different characteristics and habits. Students in this faculty possess foundational knowledge about nutrition and public health from their coursework. It is expected that they can maintain their nutritional status by meeting nutrient intake according to the Recommended Dietary Allowances (RDA), reflecting their application of public health knowledge in daily life. Therefore, this study aimed to analyze the effect of food sources on body fat percentage among these students.

## **2 Materials and methods**

This quantitative study employed a cross-sectional design, focusing on college students from the Faculty of Public Health at Diponegoro University, specifically the 2021 and 2022 cohorts, totaling 726 students. The sample consisted of 140 individuals, divided into two groups: 70 students with food sources from purchases and 70 with homemade sources. The sampling technique used was proportional random sampling. The exclusion criteria were withdrawal during the research process, illness at the time of the study, and absence from Semarang during the research. The inclusion criteria were willingness to participate as respondents, being an active regular student from the 2021 or 2022 cohort, and being aged between 19 and 24 years.

The independent variable in this study was food sources, determined using a research questionnaire. The dependent variable was body fat percentage, measured with the Innerscan Tanita BC 541 device. The mediating variable was nutrient adequacy, assessed via interviews using a 24-hour food recall form for both weekdays and weekends. Nutrient adequacy calculations were conducted with the Food Composition Database (DKBM) on Nutrisurvey and compared to the Recommended Dietary Allowances (RDA), classified as high ( $\geq 110\%$  RDA) or deficit ( $< 110\%$  RDA) [21]. The confounding variables included gender, nutritional knowledge, pocket money, place of residence, hometown, and eating habits, collected via research questionnaires. Physical activity data were obtained through interviews using a 24-hour activity recall form, categorized by the Physical Activity Level (PAL) as active (1.70-2.40) or inactive ( $\leq 1.69$ ) [22]. The independent variable in this study was the food source, determined through scores from a research questionnaire on daily food acquisition methods. The dependent variable was body fat percentage, an indicator of nutritional status. This percentage was calculated as the ratio of body fat mass to total body weight and measured using the Innerscan Tanita BC 541 device. The mediating variable was the level of nutritional adequacy, assessed by comparing nutrients consumed with the nutritional adequacy value

using a 24-hour food recall form for both weekdays and weekends. Nutritional adequacy was calculated using the Food Composition Database (DKBM) on Nutrisurvey. These results were then compared with the Recommended Dietary Allowance (RDA), classified as high ( $\geq 110\%$  RDA) or deficient ( $< 110\%$  RDA) [19]. The confounding variables included gender, categorized as male or female; nutritional knowledge, measured by the score of correct answers to questions on balanced nutrition guidelines, nutrient functions, food sources, and effects obtained through a research questionnaire; and pocket money, indicating the monthly amount received by students in rupiah. The place of residence during college and hometown, indicating the student's geographic origin, were also considered, along with eating habits, which reflected behavior in meeting nutritional needs. Data for these variables were collected using a research questionnaire. Physical activity was another variable, scored based on activities reported over the past 24 hours through a 24-hour activity recall form, and categorized by the Physical Activity Level (PAL) as active (1.70-2.40) or inactive ( $\leq 1.69$ ) [20].

The data in this study were not normally distributed. Bivariate analysis used the Chi-square test to determine the relationship between independent variables and the dependent variable. Variables with a p-value of less than 0.25 from the bivariate analysis were subjected to multivariate analysis to determine which variables exerted the most significant influence on body fat percentage. P-value of less than 0.05 indicates statistical significance. The study received approval from the Research Ethics Committee of the Faculty of Public Health at Diponegoro University, approval number 662/EA/KEPK-FKM/2023.

## 3 Results

### 3.1 Characteristics of College Students

Across all age groups, the percentage of college students sourcing food from cooking and buying was the same, indicating no significant differences. The majority of students in both groups were from the 2022 cohort, with no significant differences observed. Regarding physical activity, most participants in both groups were inactive, also resulting in no significant differences. This indicates that age, cohort, and physical activity levels among the two groups were homogeneous.

In contrast, the gender variable ( $p = 0.000$ ) showed significant differences, with a higher proportion of female students in the cooking group compared to the buying group. Significant differences were also observed for the residence variable ( $p = 0.000$ ), as most students in the buying group lived in dormitories. The nutritional knowledge variable ( $p = 0.002$ ) indicated significant differences, with students in the cooking group having better nutritional knowledge than those in the buying group. Additionally, the pocket money variable ( $p = 0.000$ ) showed significant differences, with students in the purchasing group receiving higher allowances. Similarly, for the eating habits variable ( $p = 0.000$ ), significant differences were found, with poor eating habits predominant in the buying group. A complete overview of the characteristics by food source can be found in Table 1.

**Table 1.** Characteristics of College Students

Characteristics	Food sources		Total	p
	Cooking	Buying		
<b>Age (n,%)</b>				
19 years	25 (52.1)	23 (47.9)	48 (100)	0.917 <sup>a</sup>
20 years	29 (46.8)	33 (53.2)	62 (100)	
21 years	15 (53.6)	13 (46.4)	28 (100)	
22 years	1 (50)	1 (50)	2 (100)	
<b>Gender (n,%)</b>				
Female	65 (58)	47 (42)	112 (100)	0.000 <sup>*b</sup>
Man	5 (17.9)	23 (82.1)	28 (100)	
<b>Generation (n,%)</b>				
2021	34 (50)	34 (50)	68 (100)	0.735 <sup>b</sup>
2022	36 (50)	36 (50)	72 (100)	
<b>Place of residence (n,%)</b>				
Dormitory	41 (37.3)	69 (62.7)	110 (100)	0.000 <sup>*b</sup>
Living with parents	29 (96.7)	1 (3.3)	30 (100)	
<b>Hometown (n,%)</b>				
Central Java	52 (68.4)	24 (31.6)	76 (100)	0.000 <sup>*b</sup>
Outside Central Java	18 (28.1)	46 (71.9)	64 (100)	
<b>Physical activity (n,%)</b>				
Inactive	63 (49.6)	64 (50.4)	127 (100)	0.771 <sup>b</sup>
Active	7 (53.8)	6 (46.2)	13 (100)	
<b>Nutritional knowledge (n,%)</b>				
Low	21 (35)	39 (65)	60 (100)	0.002 <sup>*b</sup>
High	49 (61.3)	31 (38.8)	80 (100)	
<b>Pocket Money (n,%)</b>				
High	29 (34.1)	56 (65.9)	85 (100)	0.000 <sup>*b</sup>
Low	41 (74.5)	14 (25.5)	55 (100)	
<b>Eating habits (n,%)</b>				
Not good	23 (31.5)	50 (68.5)	73 (100)	0.000 <sup>*b</sup>
Good	47 (70.1)	20 (29.9)	67 (100)	

Description : <sup>a</sup>Fisher’s Exact Test; <sup>b</sup>Chi-Square Test; \*p<0.05

### 3.2 The level of nutritional adequacy among college students

The data indicated no significant differences in nutrient adequacy levels (energy, protein, carbohydrates, fat) between college students obtaining food from homemade and purchasing. However, on average, students who cooked had higher nutrient adequacy levels compared to those who bought their food. A comprehensive analysis of nutrient adequacy levels among students is presented in Table 2.

**Table 2.** Analysis of nutrient adequacy levels among college students

Food Sources	Energy adequacy level		Protein adequacy level		Carbohydrates adequacy level		Fat adequacy level	
	Mean±SD	p	Mean±SD	p	Mean±SD	p	Mean±SD	p
Buying	82.01 ± 32.59	0.601 <sup>a</sup>	109.71 ± 43.88	0.711 <sup>a</sup>	67.42 ± 27.87	0.629 <sup>a</sup>	103.27 ± 87.49	0.758 <sup>a</sup>
	82.56 ± 32.26		112.49 ± 47.67		67.53 ± 26.40		107.28 ± 56.13	

Description: <sup>a</sup>Mann Whitney Test; \*p<0.05

### 3.3 Body fat percentage among college students

The average body fat percentage among college students was  $29.18 \pm 8.98$ , with a maximum of 49.3%. Chi-square analysis indicated an association between food sources and body fat percentage ( $p = 0.000$ ). Students buying food (67.1%) had a higher body fat percentage compared to those with homemade food (31.4%). However, the Mann-Whitney test showed no significant differences between the two groups' body fat percentages. Students buying food had a higher average body fat percentage than those consuming homemade food. The distribution of body fat percentage based on food sources is detailed in Table 3.

**Table 3.** Distribution of body fat percentage among college students

Food sources	Body fat percentage		p	Mean±SD	p
	Healthy	Excess			
Buying (n,%)	23 (32.9)	47 (67.1)	0.000**	30.26±10.33	0.127 <sup>b</sup>
Cooking (n,%)	48 (68.6)	22 (31.4)		28.11±7.30	

Description : <sup>a</sup>Chi-Square Test; <sup>b</sup>Mann whitney Test; \* $p < 0.05$

### 3.4 Relationship of other factors with body fat percentage

The bivariate analysis revealed relationships between energy adequacy level ( $(p = 0.012)$ ), carbohydrate adequacy level ( $p = 0.004$ ), nutritional knowledge ( $p = 0.001$ ), pocket money ( $p = 0.008$ ), residence ( $p = 0.049$ ), and hometown ( $p = 0.000$ ) with body fat percentage among college students. Detailed results are presented in Table 4.

**Table 4.** Analysis of the relationship between physical activity and other factors with body fat percentage among college students

Variable	Body fat percentage		p
	Healthy	Excess	
<b>Physical activity (Average±SD)</b>	1.39±0.17	1.38±0.15	0.412 <sup>a</sup>
Inactive ( $\leq 1.69$ )	63 (49.6)	64 (50.4)	
Active (1.79-2.40)	8 (61.5%)	5 (38.5)	
<b>Energy adequacy level (Average±SD)</b>	79.28±28.97	85.36±35.36	0.012 <sup>a*</sup>
High ( $\geq 100\%$ RDA)	10 (31.3)	22 (68.8)	
Deficit ( $< 110\%$ RDA)	61 (56.5)	47 (43.5)	
<b>Protein adequacy level (Average±SD)</b>	108.44±41.67	113.85±49.61	0.629 <sup>a</sup>
High ( $\geq 100\%$ RDA)	27 (48.2)	29 (51.8)	
Deficit ( $< 110\%$ RDA)	44 (52.4)	40 (47.6)	
<b>Carbohydrate adequacy level (Average±SD)</b>	65.65±24.23	69.35±29.74	0.004 <sup>a*</sup>
High ( $\geq 100\%$ RDA)	7 (25.9)	20 (74.1)	
Deficit ( $< 110\%$ RDA)	64 (56.6)	49 (43.4)	
<b>Fat adequacy level (Average±SD)</b>	101.43±51.95	109.23±52.45	0.236 <sup>a^</sup>
High ( $\geq 100\%$ RDA)	22 (44)	28 (56)	
Deficit ( $< 110\%$ RDA)	49 (54.4)	41 (45.6)	
<b>Gender (n,%)</b>			0.237 <sup>a^</sup>
Female	54 (56.8)	58 (55.2)	
Male	17 (60.7)	11 (39.3)	

Variable	Body fat percentage		p
	Healthy	Excess	
<b>Nutritional knowledge (n,%)</b>			
Low	20 (33.3)	40 (66.7)	0.001 <sup>a*</sup>
High	51 (63.7)	29 (36.3)	
<b>Pocket money (n,%)</b>			
High	35 (41.2)	50 (58.8)	0.008 <sup>a*</sup>
Low	36 (65.5)	19 (34.5)	
<b>Eating habits (n,%)</b>			
Not good	33 (45.2)	40 (54.8)	0.174 <sup>a^</sup>
Good	38 (56.7)	29 (43.3)	
<b>Place of residence (n,%)</b>			
Dormitory	51 (46.4)	59 (53.6)	0.049 <sup>a*</sup>
Living with family/parents	20 (66.7)	10 (33.3)	
<b>Hometown (n,%)</b>			
Central Java	50 (65.8)	26 (34.2)	0.000 <sup>a*</sup>
Outside Central Java	21 (32.8)	43 (67.2)	

Description : <sup>a</sup>Chi-Square Test; <sup>^</sup>p<0.25; \*p<0.05

Based on the multivariate analysis, the most dominant factors influencing body fat percentage among college students were food sources (OR = 4.6; CI: 1.804-11.572; (p = 0.001), carbohydrate adequacy level (OR = 7.8; CI: 1.977-30.469; (p = 0.003), nutritional knowledge (OR = 3.0; CI: 1.280-6.949; (p = 0.011), and gender (OR = 5.2; CI: 1.675-16.088; (p = 0.004). The multivariate analysis yielded an R-squared value of 0.383, indicating that these factors contributed 38.3% to students' body fat, while 61.7% was influenced by other factors. Detailed results are presented in Table 5.

**Table 5.** Multivariate analysis of the association of physical activity and other factors with body fat percentage among college students

Variables	S.E.	OR	CI 95%	p	R Square
Food sources	0.474	4.6	1.804-11.572	0.001*	0.383 <sup>^</sup>
Physical activity	0.719	1.6	0.388-6.502	0.520	
Energy adequacy level	0.972	1.3	0.191-8.622	0.977	
Protein adequacy level	0.548	0.4	0.130-1.115	0.078	
Carbohydrate adequacy level	0.698	7.8	1.977-30.469	0.003*	
Fat adequacy level	0.752	1.1	0.263-5.010	0.855	
Gender	0.577	5.2	1.675-16.088	0.004*	
Nutritional knowledge	0.432	3.0	1.280-6.949	0.011*	
Pocket money	0.488	1.3	0.495-3.350	0.603	
Eating habits	0.475	0.8	0.322-2.069	0,669	
Place of residence	0.581	0.7	0.212-2.065	0.477	
Hometown	0.436	0.5	0.203-1.122	0.090	

Description : \*p<0,05; <sup>^</sup>Nagelkerke R square

## 4 Discussion

College students with excess body fat accounted for 49.3%. Those who bought food had a higher body fat percentage compared to those who cooked. This is attributed to the transition from adolescence to adulthood, a period marked by lifestyle changes including eating patterns and unhealthy snacking habits [7, 21]. Food recall results indicated high consumption of fat from sources like vegetable oil, chicken, fried rice, and mendoan, all of which are high in fat and low in fiber. These findings exceed those from Vietnam, where overweight prevalence was 3.23% and obesity 0.72% [22].

In this study, food sources significantly influenced excess body fat among college students, as shown in both bivariate and multivariate analyses ( $p = 0.001$ ). The odds ratio (OR) was 4.6 (95% CI: 1.804–11.572), indicating that students who purchased food had a 4.6 times higher risk of excess body fat compared to those consuming homemade food. This is attributed to the nutritional quality, as students who bought food often prioritized price and taste over nutritional content, leading to increased body fat percentage. The questionnaire results indicated that the most frequently visited food purchasing locations were Tegal stalls ("warteg") and green bean porridge stalls ("burjo") (46.4%). Commonly purchased items included white rice, fried chicken, fried rice, fried eggs, mendoan tempeh, and sweet tea. Food sources affected portion sizes and meal frequency, as students preferred larger portions when eating out but consumed fewer meals throughout the day. The questionnaire also showed that students typically ate fewer than three times daily. College students who habitually skipped breakfast may have experienced increased hunger in the afternoon and evening, leading to higher insulin production and greater fat accumulation [23]. Predominantly living in dorms (78.6%), these students preferred quick, tasty, and affordable food. Questionnaire results indicated a tendency to consume unhealthy foods such as fast food and snacks like chocolate bananas, donuts, sausages, spicy tofu, mud cakes, risoles, and fried snacks. Additionally, students favored foods high in fat, consistent with findings that their main fat sources were vegetable oil, fried rice, and chicken. A study in Bekasi reinforced these findings, showing that food availability and diversity were related to nutritional status [11].

Another factor influencing excess body fat was carbohydrate intake ( $p = 0.003$ ). The odds ratio (OR) was 7.8 (95% CI: 1.977–30.469), indicating that students with high carbohydrate adequacy were 7.8 times more likely to have excess body fat than those with a deficit. Students frequently consumed sweetened tea and fast food more than three times a week (33.6%), along with sugary snacks like chocolate bananas, donuts, kue lumpur, and bolu kukus. Sugar, a simple carbohydrate, dissolved in water, was easily digested, and absorbed quickly, leading to excess energy intake [24]. Common carbohydrate sources included white rice, granulated sugar, and noodles—products high in refined carbohydrates, which lack nutrients and can trigger fat accumulation, disrupt fat oxidation, and affect gut health, contributing to weight gain [25]. This excessive carbohydrate intake led to glycogen and fat accumulation in the body [26]. These findings are consistent with research in Jakarta, which showed a significant relationship between carbohydrate adequacy and nutritional status [27].

The multivariate analysis indicated that nutritional knowledge significantly influenced body fat percentage ( $p = 0.011$ ). The odds ratio (OR) was 3.0 (95% CI: 1.280–6.949), suggesting that students with low nutritional knowledge were 3.0 times more likely to have excess body fat compared to those with high nutritional knowledge. Nutritional knowledge forms the foundation of understanding food and its nutritional content, guiding informed food choices based on quality and quantity [28, 29]. Individuals with high nutritional knowledge tend to have better nutritional status [29, 30]. This was supported by a study in Jakarta linking nutritional knowledge to central obesity ( $p = 0.026$ ) [27].

Gender was another factor influencing body fat percentage ( $p = 0.004$ ). The odds ratio (OR) was 5.2 (95% CI: 1.675-16.088), indicating that female students were 5.2 times more likely to have excess body fat compared to male students. This difference arises from higher body fat percentages in females, influenced by hormonal factors affecting fat distribution. Females typically have about 10% more body fat than males at the same BMI, due to greater subcutaneous fat in the abdominal and gluteofemoral regions [31]. Estrogen increases body fat in females, while testosterone in males tends to increase muscle mass [32]. These findings are consistent with the results of research based on data from Indonesia's Global School-based Student Health Survey (GSHS), which indicates that young females are at a higher risk of becoming obese than males [33].

Physical activity, nutritional adequacy (energy, protein, fat), and eating habits did not influence body fat percentage because most students were inactive, had high nutritional adequacy, and poor eating habits. Variables such as pocket money, residence, and hometown also had no effect, as students generally had high pocket money, lived in dorms, and were from Central Java. This indicates that the data for these variables were relatively homogeneous.

The study had limitations, as it could not accurately describe nutritional adequacy and daily physical activity due to reliance on 24-hour food and activity recall forms, which depended on participants' memory and honesty during the interviews. Additionally, the study did not explore social, genetic, psychological, or environmental factors potentially related to body fat percentage in students.

## 5 Conclusion

College students with excess body fat accounted for 49.3%. Those who obtained food from buying had a higher body fat percentage than those with homemade food sources. Food source significantly affected excess body fat in both bivariate and multivariate analyses. Other influencing factors included nutritional knowledge ( $p = 0.011$ ), gender ( $p = 0.004$ ), and carbohydrate adequacy levels ( $p = 0.003$ ).

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